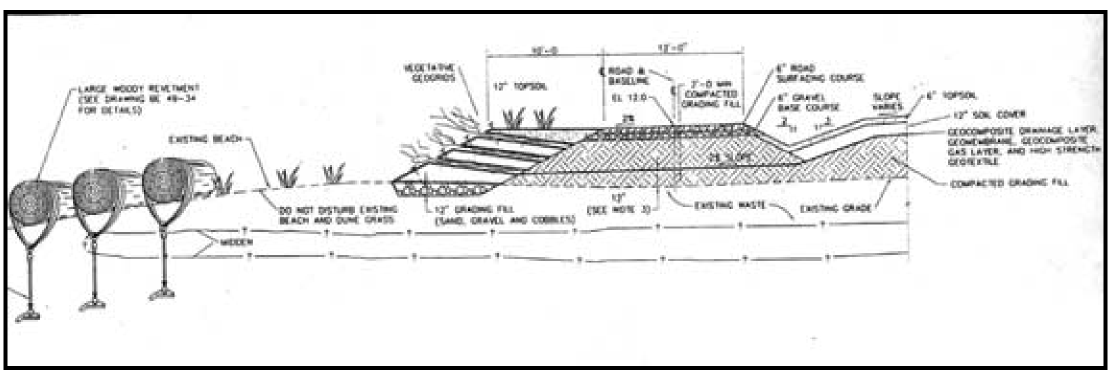
# Alternative Bank Protection Methods for Puget Sound Shorelines


Ian Zelo,
Hugh Shipman,
and
Jim Brennan


*May, 2000*





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May, 2000

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Photographs in this report, unless otherwise noted, are by the authors.

## Preface

During recent years, we have witnessed increasing concern among resource managers, local governments, and the general public about the environmental impact of shoreline armoring on Puget Sound. Armoring, in the form of seawalls, bulkheads, and riprap revetments, has been linked to reductions in littoral sediment budgets that lead to narrowing and coarsening of beaches, increased beach scour and erosion of adjacent property, and loss of riparian vegetation and associated habitats, in addition to adverse effects on beach access and aesthetics. Recent listing of several species of salmon under the Endangered Species Act has intensified the scrutiny of shoreline armoring by regulators.

As a result, agencies and property owners are searching for alternative methods of bank protection that address underlying concerns about erosion, but that minimize the potential adverse impacts on the environment. Unfortunately, little technical guidance is available to those interested in recommending, designing, or constructing alternative erosion control measures and no formal demonstration projects exist. Numerous projects have been carried out, however, but they have received no systematic review or documentation.

This report describes fifteen projects from around Puget Sound where creativity has been applied in reducing shoreline erosion. Applications include beach nourishment, bioengineering and other vegetation techniques, structural use of drift logs and woody debris, and intertidal benches. Ultimately, we need design standards and well-documented demonstrations of these technologies, but in the meantime, we hope this report helps document existing sites, increases awareness of the basic approaches, and encourages additional innovative, environmentally sound projects.

Hugh Shipman
Department of Ecology
May, 2000

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# Introduction

Rapid population growth in the Puget Sound region has brought increasing numbers of people to the shore, transforming a rural shoreline into an urban and suburban one. Vacation cabins are giving way to permanent residences and previously undeveloped shorelines are becoming waterfront communities. Natural shorelines are giving way to bulkheads, stair towers, and heavily landscaped yards.

People are drawn to the shoreline by spectacular views, beach access, and simply the pleasure of living near the water. Shoreline bluffs and beaches are dynamic environments, however, where erosion and storms are the rule rather than the exception. The shoreline actually depends on continuing erosion to maintain beaches and to support nearshore habitat, yet development is often intolerant of even relatively gradual erosion and landowners go to great expense to engineer rock and concrete structures to stabilize eroding property.

In recent years, scientists and resource managers have expressed concern about the impact of traditional erosion control measures such as seawalls and revetments both on nearshore ecology and on the public use and enjoyment of the shoreline [Canning and Shipman, 1995]. Armoring deprives beaches of their natural sources of sediment and can degrade the ecological functions of the shoreline. The cumulative impact of numerous bulkheads along a reach of shoreline may be long-term, irreversible loss of habitat and increased erosion on the property of others. One result of this is that resource agencies are carefully scrutinizing erosion control proposals in order to evaluate their potential environmental impacts and to ascertain the necessity of the project in the first place.

Property owners continue to have legitimate concerns about the effect of erosion on their land, however, and therefore considerable interest has arisen in engineering measures that protect property from serious erosion, yet have less impact on shoreline ecology and on nearby beaches. While little guidance is available on such alternative approaches, numerous projects of this nature have been constructed. This report was prompted largely by a desire to publicize these efforts and to encourage additional work in this area.

This report is intended to serve two purposes. First, it documents several recent soft bank and alternative erosion protection projects in the Puget Sound region. Second, it provides information about issues and designs that should better guide and inform future projects.

The projects in this report were carried out by different property owners, for different reasons, and in different jurisdictions. There was little awareness of other similar projects and little opportunity to learn from the experiences of others. In addition, many of these projects occur in locations where ownership or access prevents them from becoming public demonstrations (the public parks in this report are the notable exception). By describing these projects in this report, we hope that property owners and resource managers can learn of some of the types of approaches that have been tried elsewhere and some of the issues that drove their selection or influenced their design. By identifying individuals involved with the projects, whether they be contractors or agency staff, we hope to improve the sharing of information and the transfer of emerging technologies to a broader group - an audience expected to include property owners, consultants, contractors, planners and permit reviewers, resource managers, and local officials.

# *Puget Sound Shorelines and Beaches*

Puget Sound's shoreline is extremely diverse and includes rocky shores, large river deltas, tidal inlets, and many hundreds of miles of mixed sand and gravel beaches. These beaches are formed of sediment supplied by the erosion of coastal bluffs and moved by wave action and littoral drift along the shoreline. This results in a complex shoreline consisting of eroding bluffs and what geologists refer to as barrier beaches (sand spits, for example). The beaches are fairly ephemeral, always in motion, and their health depends on continued littoral sediment transport. When the supply of sediment is blocked, either by a groin or a large intertidal fill, or because the bluffs that supplied the sediment can no longer erode due to bulkheading, beaches begin to erode and to change. These physical changes to the beach impact both the survival of specific biota and degrade the larger shoreline ecosystem.

Most of Puget Sound's shoreline is residential -- much less than ten percent is commercially developed and lies in the major urban embayments [Broadhurst, 1998] -- but regulation of activities on residential property is typically less restrictive than that of non-residential sites[1]. As the locus of development has shifted in recent decades from industrial and commercial uses to residential and recreational ones, management concerns about activities such as bulkheading and small dock construction has increased. At the same time, there is growing interest in restoring heavily urbanized sites and in building habitat enhancements into commercial and industrial shoreline projects.

## Shoreline and beach ecology

Estuarine beaches such as those found in Puget Sound can be characterized as medium to low energy systems. This lower energy allows a diverse habitat to develop along a tidal gradient from the shallow subtidal across the intertidal beach and extending into the supra-tidal backshore or riparian zones. This is an extremely rich and productive ecological system that supports not only organisms in the narrow nearshore zone, but that affects the biological character of the entire Sound,

The beaches of Puget Sound provide important feeding habitat for juvenile fish, including threatened salmonids. They are also critical habitat for spawning adults and provide forage for shorebirds. Beach sediments support shellfish, epibenthic zooplankton, and other animal species. The beaches are important to flora as well: from sub-tidal *Zostera* (eel grass) to intertidal *Fucus* (rock weed) and *Salicornia* (pickleweed) communities and *Elymus* (American beach grass) in berm and backshore environments. Aquatic vegetation dominates the primary productivity and the base of the food web in these nearshore areas, but the flora also provides forage, refuge, and a variety of other habitat functions for many marine species including juvenile salmon.

In recent months, the listing of Puget Sound salmonids (bull trout, chinook, and summer chum salmon) under the Endangered Species Act[2] has renewed attention on the natural functions that our beaches provide. The beaches have been identified as critical habitat for juvenile salmon as they mature and migrate out to sea. The shallow water provides protection from larger predators, allowing more fish to survive this critical period during their rearing. Sand and gravel beaches provide necessary spawning areas for surf smelt and other forage fish on which salmon depend. Significantly, spawning depends not simply on the presence of a beach, but on the availability of a narrow range of sediment sizes in a limited tidal range on the uppermost beach [Penttila, 1995], and is therefore very sensitive to physical changes in the beach.

## Shoreline Erosion

Many shorelines on Puget Sound are eroding, although long-term erosion rates are generally quite slow. The rate and character of erosion varies considerably from one site to another, however, due to variations in wave energy, local geology and hydrology, beach condition, and other factors [Shipman, 1995]. Typical erosion rates are in the range of one foot per decade (0.1 foot/year), often reflecting the loss of several feet of bluff or bank in a landslide every twenty or thirty years. In areas of greater exposure and higher wave energy, such as parts of northern Puget Sound, rates may climb to several inches per year or more [Keuler, 1988].

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[1] The Shoreline Management Act (1971) exempts the construction of single-family residences and "normal protective bulkheads" from a Shoreline Substantial Development Permit (these activities must still conform to the policies of a local Shoreline Master Program and an SSDP exemption does not necessarily confer approval). In addition, the Hydraulics Code, administered by the Washington Department of Fish and Wildlife, applies a less restrictive standard to residential shoreline bulkhead projects than it does to non-residential ones.
[2] The National Marine Fisheries Service (NMFS) was recently petitioned to consider 18 other marine species for review. Seven marine species, in addition to coho salmon, are currently under review.

Erosion is a significant concern for shoreline property owners and for many shoreline communities. Often, the problem is related to historical land use decisions that led to development in inappropriate or risky locations. In other cases, concern about erosion stems from false perceptions about the rate or nature of erosion. Regardless of the motivation, however, the choices individuals and groups make to prevent property loss and protect shorelines fall into four broad categories: no action, land use controls, static engineering solutions, and manipulations to restore or increase beach function [Nordstrom, 1992].

## No Action

In some cases, the simplest and best response to shoreline erosion is to do nothing. Threats to upland structures may be minimal as a result of prudent setbacks and slow erosion rates and the high costs and potential impacts of erosion control measures may not be readily justified. On undeveloped shorelines, it may be far more effective and prudent to simply avoid hazardous development in the first place, rather than allow building that will require engineering measures to maintain safety into the future. This is particularly true in geologically unstable areas or in areas of rapid erosion, where proposals for structural stabilization and erosion control are likely once development begins.

Where shoreline stability is a complex function of historic shoreline erosion and upland mass-wasting (landslides) related to geology and hydrology (drainage), conventional bulkheading is often an inappropriate or ineffective solution. In these cases, which apply to many shorelines, "no action" may be appropriate because the only viable solutions are far more technically sophisticated and expensive than justified by the value of the property. It may be much cheaper and more effective to relocate a house or a septic system than to address stability directly.

Along shorelines where the ecological value of the shore is particularly high or where continued erosion is necessary to maintain nearby beaches (*feeder bluffs*), a policy of no action may be necessary to protect the public interest. On the other hand, on developed property where an existing home or public facility is threatened by erosion, doing nothing is often not a palatable or practical solution, resulting in a compromise between private and public interests.

## Land Use Decisions

Land use management includes zoning restrictions, local land use designations and development regulations. Such measures can be used to keep structures out of harm's way by increasing required setbacks from the water. They can establish performance standards for erosion protection projects and shoreline structures. They can also be used to mandate post-construction standards such as revegetation or beach and backshore restoration requirements.

Setbacks are a simple and effective way to both protect resident investment and the natural beach environment. Land use controls have much potential for controlling future problems but are of more limited utility when focused on structures that have already been constructed. Other alternatives than setbacks must be typically be considered in these cases, although in some regions relocation of structures threatened by erosion is relatively common.

## Static Structures

Erosion control on Puget Sound has traditionally been achieved through the use of engineered[3] structures such as seawalls, bulkheads, revetments, and upland retaining walls. They can be constructed of rock, concrete, wood, metal, or other materials, but are generally intended as static devices to resist wave action or to retain upland soils. A thorough description of these approaches is not appropriate here, but a number of references can be found [Cox and others, 1994; Corps of Engineers, 1981; Downing, 1983].

These common erosion control structures have several benefits: 1) engineering standards may have been developed and tested and consultants and contractors have extensive experience building them; 2) if designed correctly, such structures can effectively protect the upland from erosion; 3) costs may be more predictable (even if high), due to familiarity and experience; and 4) well-built structures often require minimal maintenance over an extended period of time. Among the disadvantages of these structures is that they do nothing to protect the beach itself and may exacerbate its loss, they displace critical shoreline and adjacent riparian habitat, they reflect wave energy back onto the beach, and they cutoff sources of sediment needed to maintain nearby beaches.

## Concerns about erosion control measures on Puget Sound

The conventional response to shoreline erosion in the Puget Sound region has been the construction of rock or concrete bulkheads. Although often effective at protecting against wave-induced erosion, these structures can cause a suite of negative side effects. Among the documented adverse impacts of bulkheading [Canning and Shipman, 1994; Macdonald and others, 1994; Thom and others, 1994] are the following:

- Shoreline armoring or "hardening" can cut off the sediments supplied to the beaches by erosion. This leads to sediment starved conditions that exacerbate erosion and alter beach composition.

[3] Here, we use the term "engineered" to describe built structures, as opposed to landuse controls, for example. Relatively few erosion control structures are actually designed and certified by engineers on a project-specific basis. Although many contractors employ designs that are based on solid engineering principles, we also observe many structures that do not even conform to standard industry standards. In addition, sites with complex stability issues often require geotechnical or geological engineering input - it is not enough to have a well-engineered bulkhead if the slope above it fails due to hydrologic factors.

- Hard structures, especially when vertical, reflect wave energy back onto the beach, causing scour and modifying the energy regime on the beach.

- Increased wave energy and loss of sediment supplies can lead to coarsening of the beach as sand and small gravel is progressively winnowed from the beach. The result is a shift to coarser gravel and cobble beaches and more frequent exposure of underlying hardpan (glacial sediment) or bedrock.

- Installation of bulkheads often requires that upland vegetation be removed and can prevent mature native vegetation from becoming re-established in the riparian zone.

Bulkheads and related bank protection measures have *cumulative* impacts. Whereas individual structures may not lead to large, short-term beach changes, the effect in aggregate of many such structures may be significant, particularly as they affect littoral sediment supplies and beach substrate. Much of Puget Sound's shoreline is residential and as a consequence, large portions of the shoreline are, or are likely in the future be, armored. Currently, approximately 30% of the shoreline is armored [Bailey and others, 1998], and in many areas, this proportion approaches 100% over extensive reaches of shoreline.

## Alternative means of erosion control

Beaches in their natural state have a certain amount of built in erosion protection. Gradual beach slopes dissipate wave energy and protect the toe of the bluff from direct wave action except at the highest tides. The movement of beach sediment also dissipates wave energy. Coarse, permeable beaches (such as the gravel-dominated beaches found in this region) allow incoming waves (swash) to drain rapidly into the beach, reducing the erosive backwash. Gravel beaches can actually build up during storms. Beach and bluff erosion provides sediment to the littoral system, maintains the volume of nearby beaches, and reduces erosion elsewhere. The presence of drift logs and other large woody debris helps to retain sediments and absorb wave energy. Dune grass and berm vegetation can greatly increase the resilience of beaches to storm waves.

Just as human efforts to control erosion can cause degradation of these natural systems, engineering design can be applied to address the adverse impacts of conventional structures as well as to restore or enhance beach functions that have been lost. Beach nourishment projects, where sediment is artificially added to the beach, and biotechnical bank stabilization measures and bioengineering, where vegetation is planted specifically to address erosion and slope stability, are examples of such efforts, as are more elaborate efforts at beach reconstruction and shoreline habitat restoration. The success of these alternative approaches will be measured by their ability to provide bank protection while also preserving or restoring natural physical and biological shoreline processes.

# Case Examples

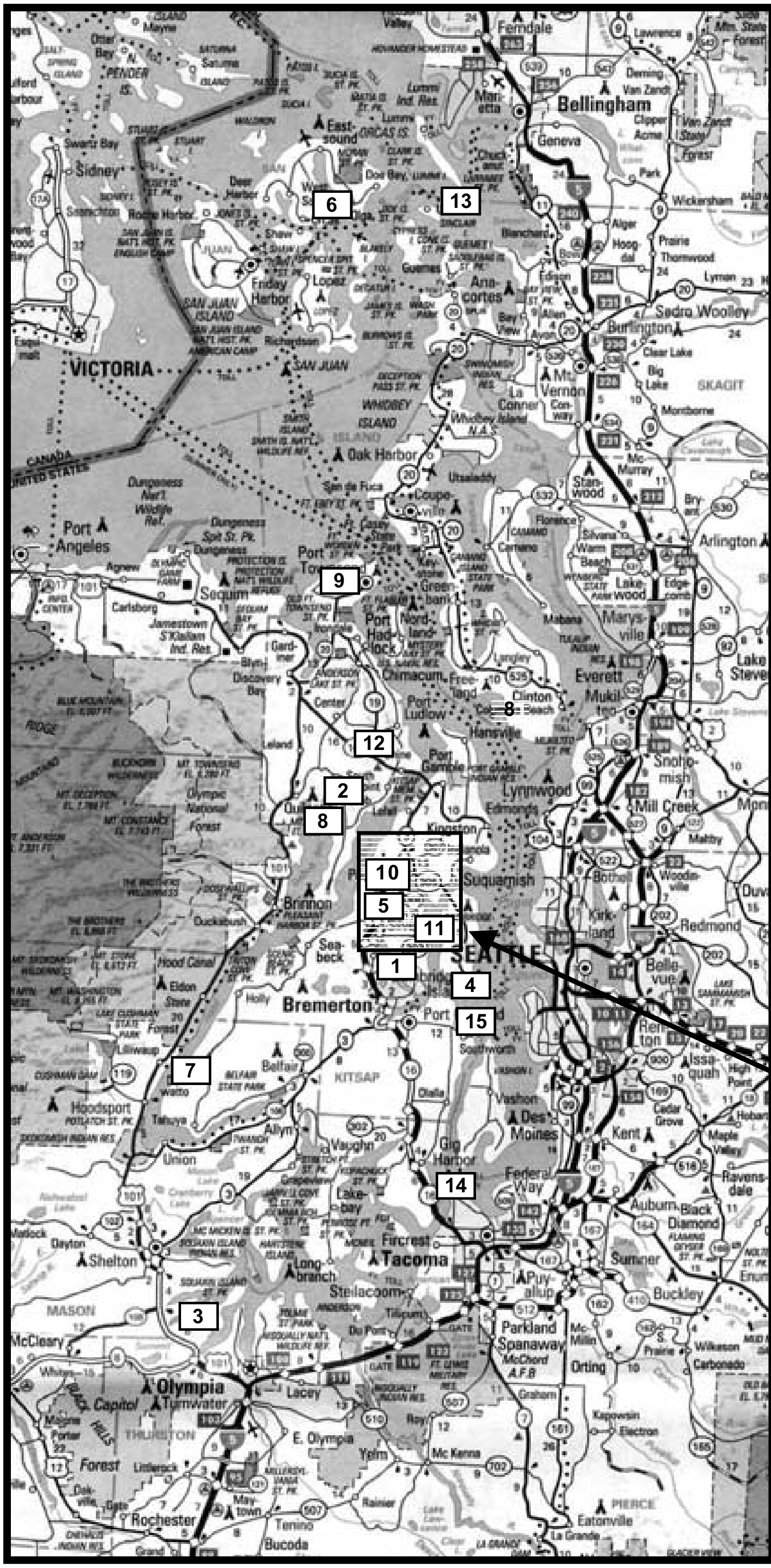
The primary objective of this report was to identify and describe a variety of projects where creative approaches had been taken to address shoreline erosion. The following section contains detailed descriptions of fifteen projects from around the Puget Sound region (see Figures 1 and 2). A summary of the projects is provided in Table 1.

We began this project with an initial list of projects and contact people. Phone interviews, meetings, and site visits were carried out, primarily by the first author of this report (Zelo). From our discussions with individuals involved with these projects we identified several additional sites to add to the survey. Some sites were eventually dropped due to lack of information or because they turned out to be inappropriate examples for this particular study.

Although several beach nourishment projects were included, we chose to focus on other types of examples since Puget Sound nourishment projects will be covered more completely in a report to completed later this spring by Shipman (we are aware of approximately 30 nourishment projects in Puget Sound).

We attempted to acquire a common slate of information on each site, in addition to photographs and design drawings. This information was obtained from individuals involved with the projects, permit files, or reports where available. We found that documentation of these projects was inconsistent and some types of data were simply unavailable. For example, cost information was particularly difficult to obtain and where it was available, was often difficult to interpret (costs often included project costs unrelated to the shoreline work or failed to include the costs associated with volunteer or in-house efforts).

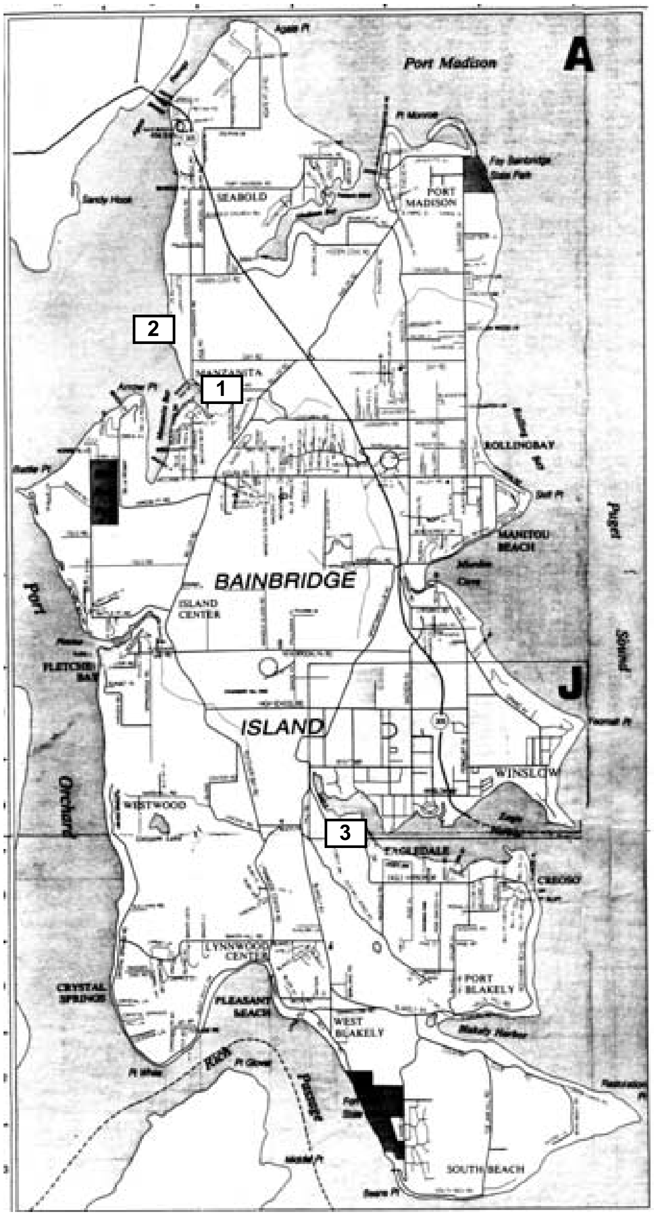
# Figure 1.  Puget Sound Location Map




1. Blake Island
2. Blomquist Residence
3. Baum Residence
4. Cormorant Cove
5. Dick Residence
6. Driftwood Beach
7. Dully Residence
8. Floral Point
9. Indian Island
10. Odermat Residence
11. Place Eighteen
12. Salsbury Point Park
13. Samish Beach
14. USG/Thermofiber
15. Weather Watch Park

**See Figure 2, Bainbridge Island detail**

## Figure 2. Bainbridge Island Location Map




1. **Dick Residence**
2. **Odermat Residence**
3. **Place Eighteen Condos**

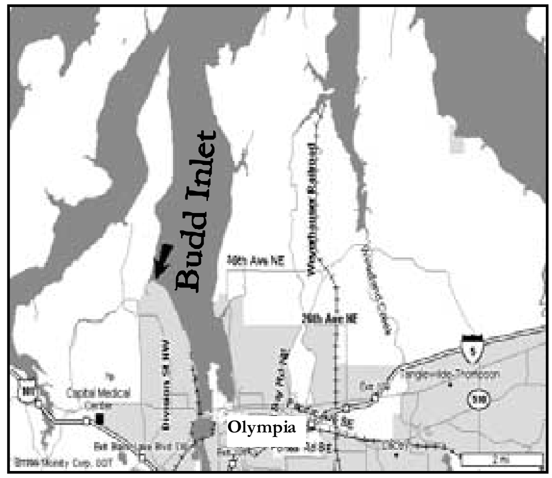
## Table 1. Overview of Projects

| Site | Region | Wave Energy | Beach Type | Project Type | Date completed |
|---|---|---|---|---|---|
| Blake Island State Park | Puget Sound, West of Seattle | High | Beach | Beach nourishment, buried sheet pile wall, large woody debris | Planned |
| Baum Residence | Budd Inlet, Olympia | Low | Bluff | Rock bulkhead, soil nails, drainage system, geogrid, revegetation | Summer 1999 |
| Blomquist Residence | Hood Canal | Medium | Beach / Stream mouth | Anchored logs, revegetation | September 1999 |
| Cormorant Cove | Alki Beach | High | Beach / Low bluff | Perched pocket beach, rock toe | Planned |
| Dick Residence | Manzanita Bay, Bainbridge Island | Very Low | Low bluff | Quarry spall toe protection, anchored logs | Summer 1998 |
| Driftwood Beach, Blakely Island | San Juan Islands | Medium | Beach | Beach nourishment, revegetation | March 1999 |
| Dully Residence | South Hood Canal | Low | Beach | Anchored logs, buried rock revetment | Summer 1998 |
| Floral Point, SUBASE Bangor | Hood Canal | Medium | Beach / Filled spit and lagoon | Beach nourishment, drift logs, revegetation | November 1997 |
| Indian Island | North end of Indian Island, South of Port Townsend | High to Very Low | Beach / Filled spit and lagoon | Anchored logs, geogrid, rip-rap revetment | June 1997 |
| Odermat Residence | West side of Bainbridge Island | Low | Bluff | Rip-rap bulkhead, quarry spall toe protection, habitat enhancement rocks | 1998 |
| Place Eighteen | Eagle Harbor, Bainbridge Island | Low | Beach / Low Bluff | Quarry spall toe protection, beach nourishment | Summer 1997 |
| Salsbury Point Park | Hood Canal, N. of Hood Canal Bridge | Medium | Beach / Historic Spit | Beach nourishment | October 1995 |
| Samish Island | North side of Samish Island | High | Beach | Beach nourishment , groin | Fall 1998 |
| USG/Thermafiber | Hylebos Waterway, Commencement Bay | Very Low | Industrial waterway | Gabion mattresses, benched revetment | August 1997 |
| Weather Watch Park | West Seattle | High | Beach | Large woody debris, revegetation | Summer 1991 |

# Baum Residence

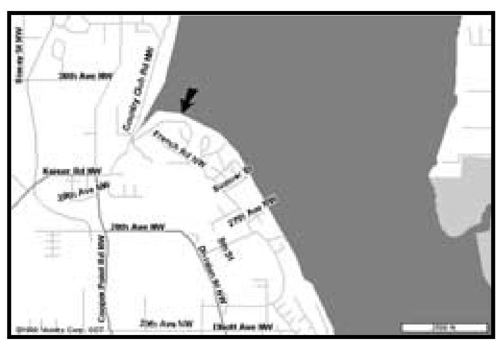
Address: **French Loop Road NW, Olympia**
Region: **West Shore of Budd Inlet**
Designer: **Agua Tierra Environmental Consulting**

| | |
|---|---|
| Contractor: | **ATEC**<br>**Sound Bulkhead (rock work)** |
| Owner: | **Baum** |
| Shoreline Type: | **Steep Bluff** |
| Project Type: | **Rip-Rap Bulkhead, Soil Nails, Biotechnical Measures** |
| Wave Energy: | **Low** |
| Tides: | **MHHW: +14.4**<br>**Extreme High: +17.56**<br>**Extreme Low: -4.5** |
| Cost: | **$160,000**<br>**Rip-Rap - $60K ($235/ft)**<br>**Soil Nails - $60K**<br>**Slope Work - $40K** |
| Date Completed: | **Summer 1999** |



Location: Baum residence in Budd Inlet

### Site History / Description



The Baum house is situated at the top of a very steep bluff on the west shore of Budd Inlet (Olympia, WA). The site is fronted by 255’ of shoreline in a relatively low energy environment. The house was build circa 1930 and the present owner bought it approximately two years ago (1997). The house is situated on a nearly vertical bluff that was masked by a 12-18” thick mat of Old English Ivy. The toe of the slope was faced with a 30-year-old timber bulkhead that was failing. Before the project began the driveway ran parallel to the shore between the house and the edge of the bluff. The homeowner noticed tension cracks in the driveway, which motivated him to have the slope stabilized.

## Project Description

Due to the nature and diversity of the problems present, this project was very complicated. There were five stages of construction. The project began with extensive preparatory work which was then followed by upper slope stabilization, slope face stabilization, toe protection and drainage improvements.

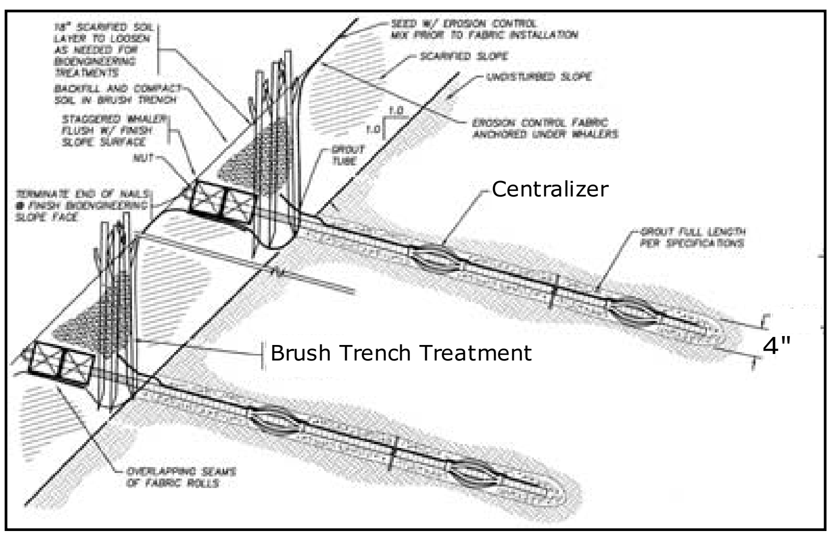
*I. Preparation: Fall 1998*

Pre-construction the slope was vertical with areas that were actually undercut. To begin the process the English Ivy was removed using manual and chemical methods. Ivy can be seen on many slopes around the Sound. It is actually a false positive. While the slope may look heavily vegetated, the root system is very shallow and it does not do much more than prevent some very superficial, precipitation derived, erosion. When the ivy was gone the slope was cut back to 1V:1H and any undercuts were filled in. This grade is about the maximum that can be maintained with a sand dominated slope like the one on site.

*II. Soil nails: Fall of 1998*

The soils on the site were glacially compacted and the slope is failing in blocks. Soil nails prevent this. At the face of the bluff each nail has a zone of support about 6-8' in diameter. The amount of support decreases depper into the slope. Similarly, the slope is under is the greatest pressure to fail at the face and becomes less stressed at depth. Nails are placed so that their areas of support overlap or touch at the slope surface (6' on center). The upper portion of the slope was secured using the following method.

Soil nailing is the process of running re-bar into the slope to help hold it together. Holes were drilled back into the slope using a drill rig lowered down the bluff from a boom truck. These holes were 4" in diameter and ranged from 15-32' deep. The nails are epoxy-coated re-bar with "centralizers" (4" donut-like spacers) placed every few feet to keep the nails in the middle of the hole. When the nails were all in place, the holes were filled by pumping in "grout". This consisted of Portland cement with some added sand. The grout bonds the nails to the earth. About 48



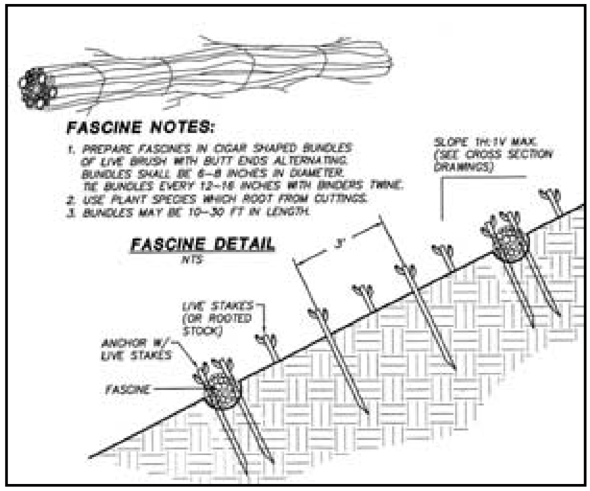
Detail: Soil Nailing

nails were put in. To insure the ivy would be dead in the spring the slope was covered with black plastic and left over the winter (98-99).

*III. Slope stabilization – lower ¾ of the slope, Spring 1999*

In this stage the lower slope was secured together using vegetative techniques.

a) "Windrow" trenches or "Brush" trenches. These reinforce the surface and the shallow mantle. Shallow trenches were cut into the bluff for every 6' of elevation. "Cigar" shaped bundles (8"x 30') of rootable whips (Hooker, Scouler & Sitka willows) were then laid in the trenched. These will grow into the slope and their root systems will provide substantial support.

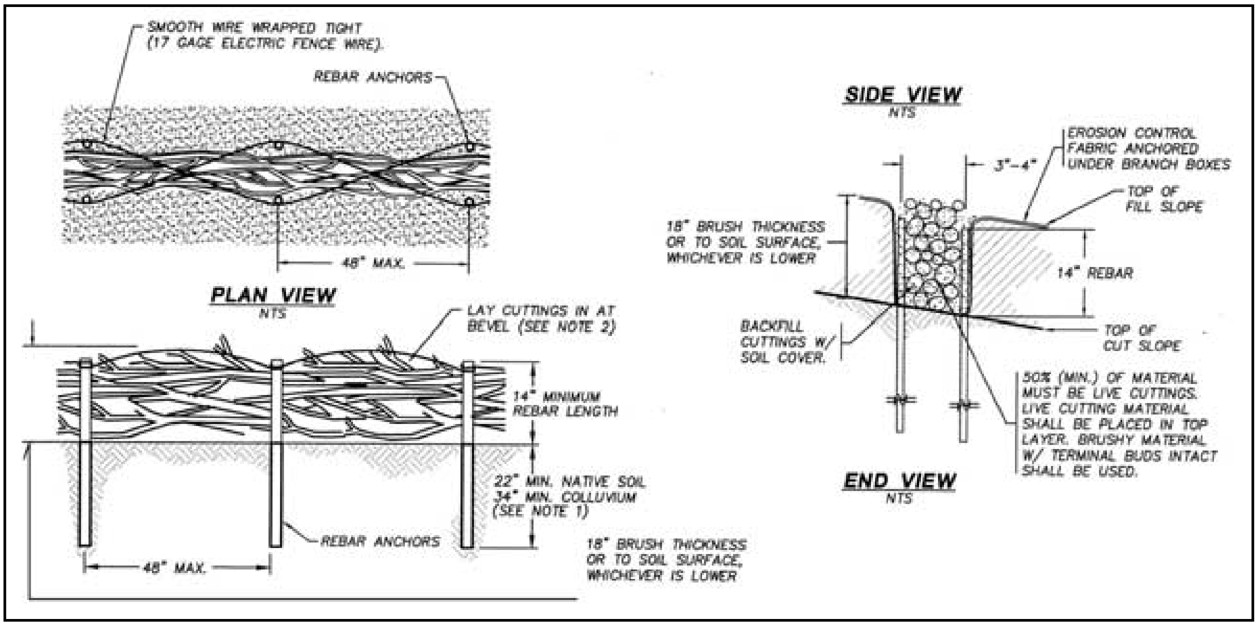


Detail: Brush Trench

b) Live staking – Cuttings of three willow species and dogwood that were about 2' long and 1-1 ½ inches thick were driven into the ground so that 4-5" remained above ground. The stakes were cut for ATEC specifically for the job. They were chosen for their species, size and even the location they were harvested from (lower slope/upper slope) so they would match the new environment as closely as possible. These measures insured that the establishment would be successful. If the installation is done with care, 90% of the installed stakes may grow well. Poor technique can result in 50-70% mortality.

c) Branch Boxes - These are similar to Brush trenches in that they use cuttings of the three willow species but they hold the material deeper in the ground. Grooves were cut into the slope (3"Wx14'D) and filled with the rootable cuttings. Re-bar stakes were then driven 3-4' into the slope every 48" on either side of the box. These were used to wire the cuttings into the slope.

d) Ground Cover Plantings - Ground cover plantings followed the brush trenches, lives stakes and branch boxes. The species included vine maple, evergreen huckleberry, salal, red elderberry and ocean spray. This rooted stock was alternated up the slope with the branch boxes and brush trenches depending on the segment of slope. In addition the slope was seeded with a custom native grass mix.




Detail: Branch Boxes

The whole slope was covered with the coir. This material will provide support and protection during the vegetation establishment period and will rot out in about three years. This third phase was completed in the spring of 1999 and the entire slope was growing vigorously by the first week in September 1999. A temporary irrigation system was installed that will be taken down after the first two growing seasons.

*IV. Toe Protection*

The old timber bulkhead was removed and replaced with a new 5' rip-rap bulkhead (6V:1H) of 6-man rock. It is 6' deep, backfilled with quarry spall and keyed into the beach 2.5-3.5 feet. After the rock was installed, pea gravel was added to the beach in front of the wall to improve the habitat for fish spawning. This was completed in the last week of August 1999 and some trail construction had yet to be completed in early September 1999.

*V. Drainage*

The drainage system on the site was improved to capture 90% of the direct precipitation that lands on the property. This prevents the water from soaking into the slope and weakening it. The water is directed into a new system that culminates in a dissipater built into the bulkhead. The water reaches the bottom of the slope and is spread out within the rock to emerge on the beach over a wide area. This reduces the possibility of beach erosion resulting from the outfall.

## Monitoring

ATEC will be monitoring the site for 2-3 growing seasons. They will use established photo points and a slope stability checklist they created for the Indian Island site.

### Success

The project is too new for success to be determined. It is also sufficiently complex that phases II through IV might be best evaluated independently.

### Alternatives Considered

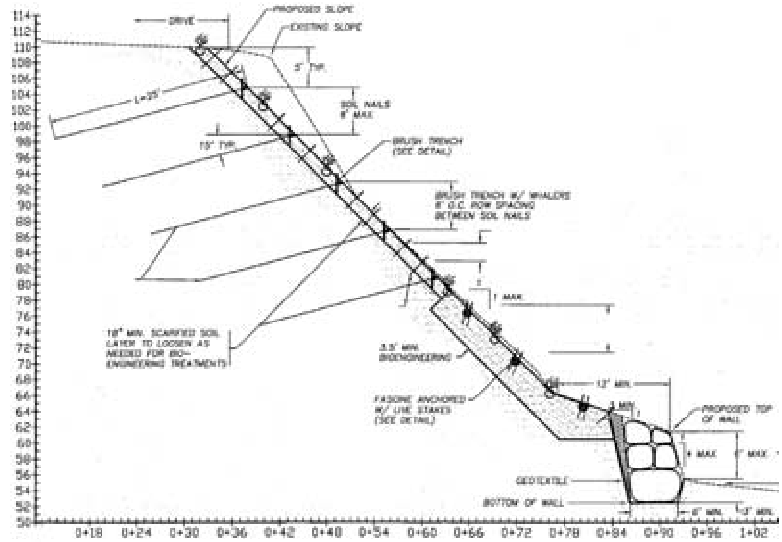
The homeowner was initially interested in a concrete bulkhead. He also wanted to maintain the vertical slope so that the driveway could remain where it was. Both of these options were discarded for the project alternative that was chosen.

### Contacts

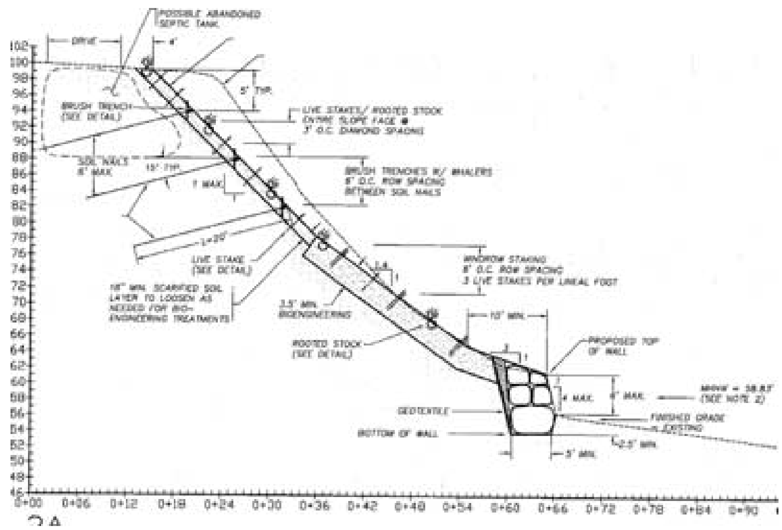
| | |
|---|---|
| Washington Department of Fish and Wildlife: | M. Schirato |
| Thurston County | R. Giebelhuas |
| Agua Tierra Environmental Consulting, Inc.: | C. Fromuth |

## Project Design Profiles

Segment A




Segment B




Segment C

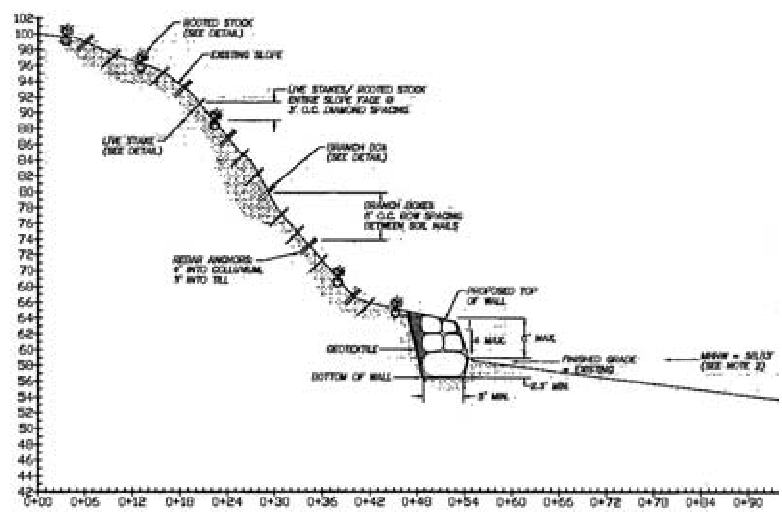


Figure 1. Vegetative slope stabilization. The bands of vegetation correspond to individual geogrid lifts. The hose in the foreground is part of new drainage system and flows into a diffuser behind the bulkhead.

Figure 2. View from the beach. The lift layers can be seen. The slope is approximately 1H:1V, compared to its original near-vertical pre-construction state. The bluff is 30+ feet tall (the rock bulkhead is 5-6 feet high).

Figure 3. Path in front of house. Prior to construction this was part of the driveway, but narrowing the path allowed more room for laying back the slope.

Figure 4. Live staking. When willow stakes are installed there is no growth - just a 1.5" portion of a 2-foot stake driven into the substrate. Four months later, vigorous growth has begun to secure soils in place.

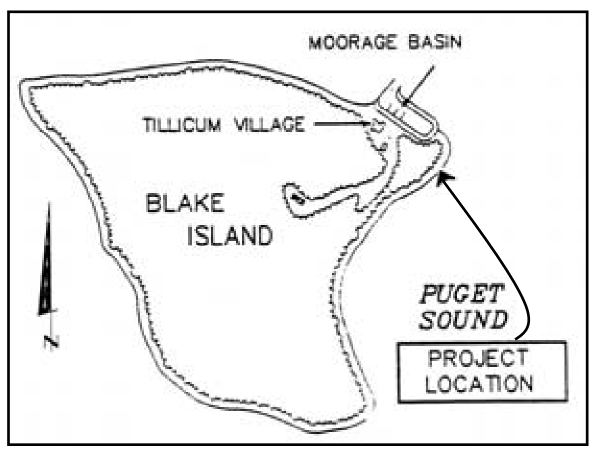
# Blake Island State Park


Location: Blake Island in Puget Sound

Address: **Blake Island State Park**
Region: **NE corner of Blake Island**
Designer: **Worthy & Associates**
Contractor: **Not Assigned Yet**
Owner: **WA State Parks**

| | | |
|---|---|---|
| Shoreline Type: | **Beach** | |
| Project Type: | **Regrade / Nourishment**<br>**Coarse Woody Debris**<br>**Buried Sheet Pile Wall** | |
| Wave Energy: | **High** | |
| Tides: | **MHHW: +11.46**<br>**Extreme High: +15.5**<br>**Extreme Low: -4.5** | |
| Cost: | **Excluding Sheet Pile:** | **~$18,000 ($30/ft)** |
| | **Sheet Pile Wall:** | **~$120,000 ($198/ft)** |
| | **Total:** | **~$138,000 ($228/ft)** |
| Date Completed: | **Scheduled - Spring 2000** | |

### Site History / Description

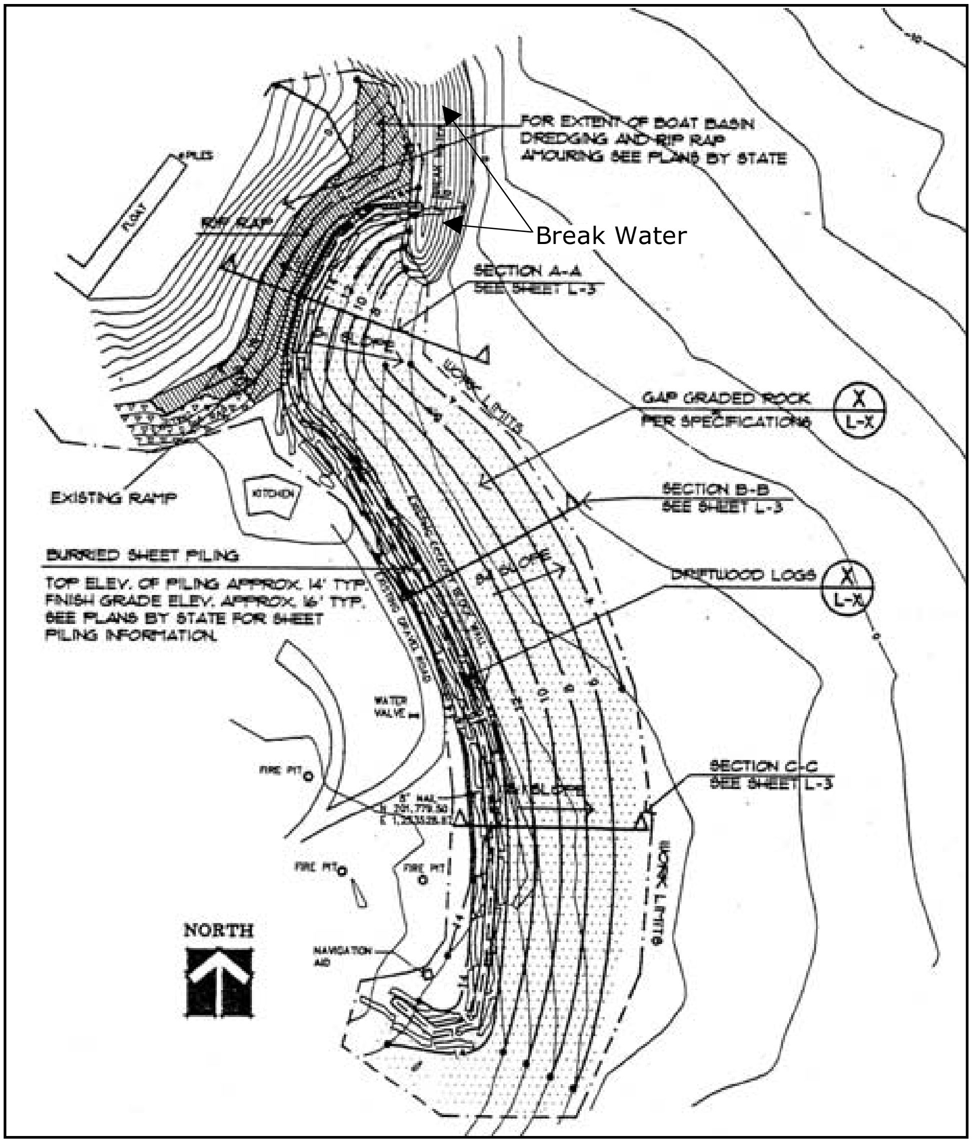



Location: Project on Blake Island

Blake Island is located in Puget Sound about equidistant between the southern tip of Bainbridge Island and the north end of Vashon Island. The State Park encompasses the entire island and the project site is just south of the boat basin in the northeast corner.

The site is approximately 600 feet long and stretches from the USCG navigation aid north to the eastern end of the rubble breakwater. Work on the backside of the breakwater (dredging and rockwork) was also proposed as part of a separate boat basin restoration project, but this element of the project has been withdrawn.

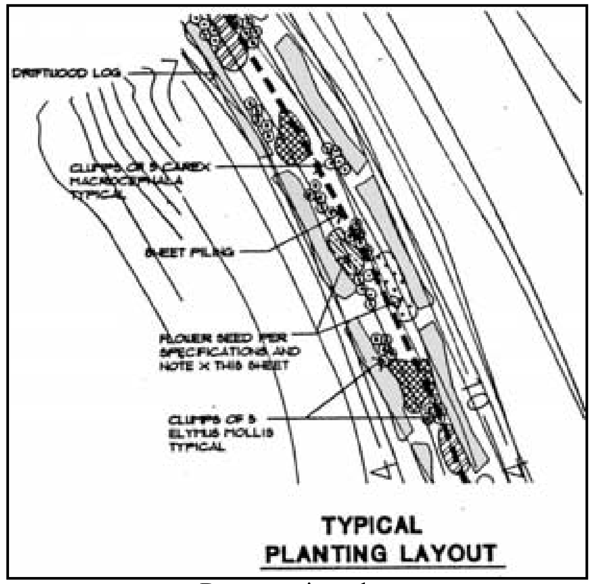
The site was originally an accretion beach fed from both the north and the south. When the boat basin was constructed in the 1970s, much of the excavated material was placed on the low-lying point where the current project is now proposed. The boat basin effectively cut off sediment input from the north and the modification of the point affected the movement of littoral drift from the south. Between the changes in littoral sediment supply and the placement of fine grained fill over the backshore and beach, erosion has been rapid. Following the severe northerly storms of late 1990, ecology blocks were placed as a temporary erosion control measure, but this structure has fared poorly and erosion has continued.




Blake Island: Site Plan

## Project Description

The beach restoration and protection will require at least five stages. It will begin with the removal of the ecology blocks that were placed as temporary erosion protection. Some of these will be reused as anchors for large woody debris. The next stage will use the dredge material from the marina and an additional 3500 $yd^3$ of 3" minus gravel to regrade the beach and build a 10'-wide berm. The new material will be much coarser and more permeable than the old fill material. This will help absorb wave swash and reduce erosive forces acting on the beach. The backshore elevation will be between +14' and +16'. A 10' sheet pile wall will be buried in the middle of the bench. It will extend vertically between +14' and +4'. Large woody debris will be anchored to buried ecology blocks and located on either side of the buried sheet pile wall for most of its length. Where the wall stretches between the kitchen and the beginning of the breakwater the logs will not be located on the marina side. Ecology blocks will be salvaged from those initially removed from the beach. The berm/backshore will be revegetated with native species.




Revegetation plan

This effort will increase the quantity and quality of natural habitat on site. It will help protect the beach against future erosion and will restore the boat basin to its former level of service.

## Monitoring

Profile monitoring will be used to track changes in the site and determine when or if additional nourishment will be necessary in the future. Three profiles will be established and measured immediately before and after the project. They will then be surveyed annually in either April or September for a period of five years. The reports will be submitted to WA Department of Ecology, WA Department of Fish and Wildlife, Kitsap County, and the Army Corps of Engineers.

## Success

The project is currently proposed to be built in spring or summer of 2000.

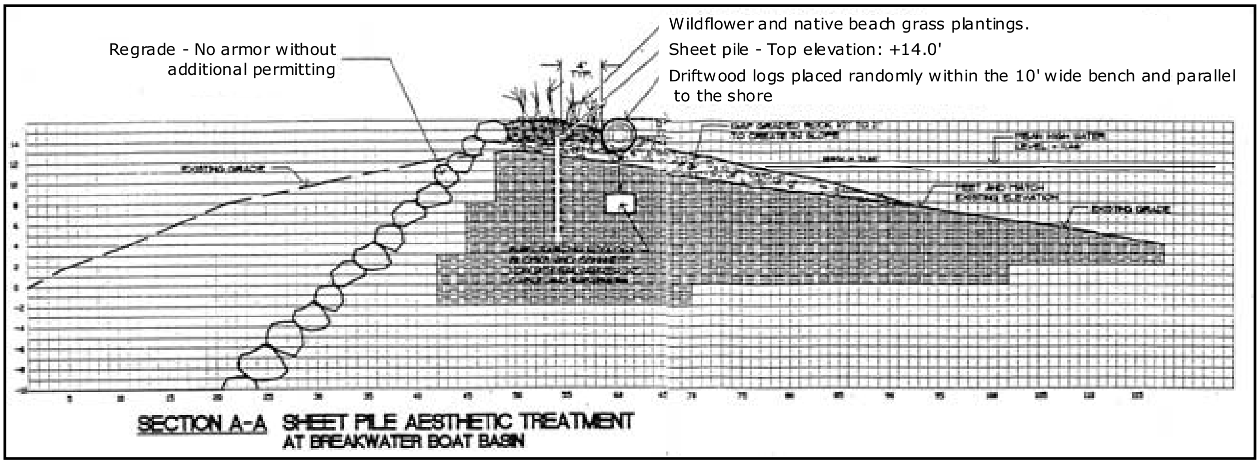
## Alternatives Considered

Several alternatives were considered for this project. The no action alternative was disregarded due to concerns about the kitchen shelter, picnic tables, and bathrooms. In addition the temporary protection is further damaging the site and needs to be removed. A rip rap revetment was considered. This was an improvement from vertical protection but it would have been poor for habitat. It is the position of the Parks and Recreation Commission to maximize natural conditions and habitat whenever possible. The third alternative was to install a rip rap revetment on the breakwater and a gravel berm on the remainder of the site. It was found that the rip-rap was unnecessary.

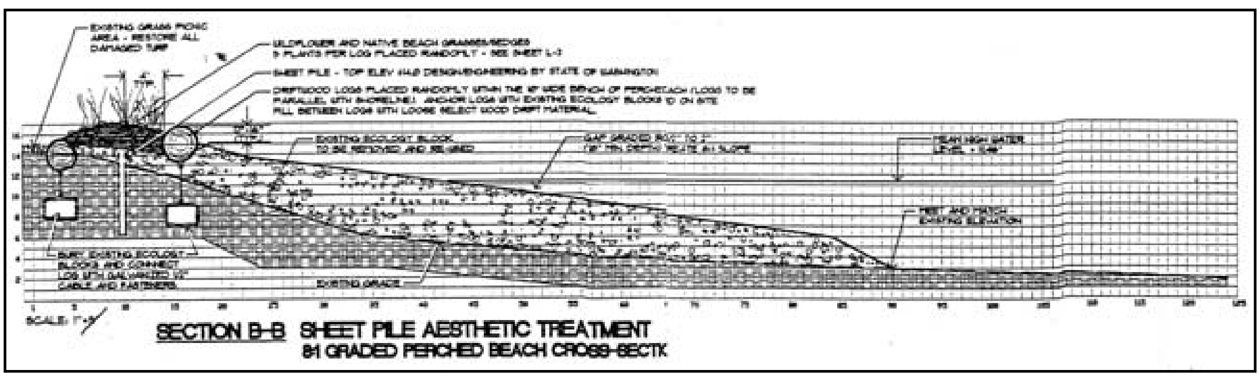
## Contacts

| | |
|---|---|
| Department of Fish and Wildlife: | D. Small<br>J. Brennan (now with King County DNR) |
| Department of Ecology: | H. Shipman |
| WA State Parks | K. Martin, J. Ward |
| Worthy & Associates | S. Worthy |
| Army Corp of Engineers | C. Barger |

## Project Design Profiles




Beach Profile: Transect A-A




Beach Profile: Transect B-B

Figure 1. Aerial view of Blake Island site.
*Photo: Ecology, KIT#707, 5-20-1992.*

Figure 2. View northwest showing temporary "ecology block" erosion protection. Note significant damage done to temporary structure. Breakwater for boat basin is in background.